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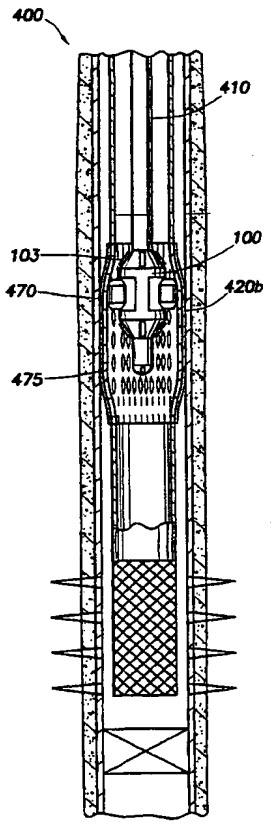
(54) Title: CREATION OF A DOWNHOLE SEAL



(57) Abstract: The present invention provides apparatus and methods for expanding tubulars in a wellbore. In one aspect, a process of sealing an annular area in a wellbore is provided in which a tubular (420a) having perforations (415) at a predetermined location and a sleeve (425) concentrically covering substantially all of the perforations is expanded into substantial contact with an inner diameter of a tubular (460), such as a casing or a liner. In another aspect, a process of sealing an annular area in a wellbore is provided in which a tubular having perforations at a predetermined location and a sleeve concentrically covering substantially all of the perforations is expanded into substantial contact with a junction between two tubulars, such as a liner and a casing, or between two liners.

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CREATION OF A DOWNHOLE SEAL

This invention relates to downhole sealing, and to an apparatus and method for use in forming an arrangement to allow creation of a downhole seal. Generally, the invention relates to the provision of a seal or packer between concentric downhole tubing, such as a bore-lining casing and production casing.

In the oil and gas exploration and production industry, bores are drilled to access hydrocarbon-bearing rock formations. The drilled bores are lined with steel tubing, known as casing or liner, which is cemented in the bore. Oil and gas are carried from the hydrocarbon-bearing or production formation to the surface through smaller diameter production tubing which is run into the fully cased bore. Typical production tubing incorporates a number of valves and other devices which are employed, for example, to allow the pressure integrity of the tubing to be tested as it is made up, and to control the flow of fluid through the tubing. Further, to prevent fluid from passing up the annulus between the inner wall of the casing and the outer wall of the production tubing, at least one seal, known as a packer, may be provided between the tubing and the casing. The tubing will normally be axially movable relative to the packer, to accommodate expansion of the tubing due to heating and the like. The packer may be run in separately from the tubing, or in some cases may be run in with the tubing. In any event, the packer is run into the bore in a retracted or non-energized position, and at an appropriate point is energized or "set" to fix the packer in position and to form a seal with the casing. A typical packer will include slips which grip the casing wall and an elastomeric sealing element which is radially deformable to provide a sealing contact with the casing wall and which energizes the slips. Accordingly, a conventional packer has a significant thickness, thus reducing the available bore area to accommodate the production tubing. Thus, to accommodate production tubing of a predetermined diameter, it is necessary to provide relatively large diameter casing, and thus a relatively large bore, with the associated increase in costs and drilling time. Further, the presence of an elastomeric element in conventional packers limits their usefulness in high temperature applications.

Therefore, there is a need to provide a means of sealing production tubing relative to

predetermined location and a sleeve concentrically covering substantially all of the perforations. An expansion tool is placed in the tubular. The expansion tool is energised causing extendable members therein to extend radially to contact an inner wall of the tubular. The tubular is thereby expanded into substantial contact with an inner diameter of the liner and/or casing.

In yet another aspect, a process of sealing an annular area in a wellbore is provided in which a tubular and an expansion tool assembly is placed in the wellbore, the tubular having perforations, or slots, at a predetermined location and a sleeve concentrically covering substantially all of the perforations. The expansion tool is energised causing extendable members therein to extend radially to contact an inner wall of the tubular, thereby expanding the tubular into substantial contact with an inner diameter of the liner and/or casing.

Some preferred embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of an expansion tool;

Figure 2 is a perspective end view in section thereof;

Figure 3 is an exploded view of the expansion tool;

Figure 4a is a section view of a sealing apparatus including an expansion tool disposed on an end of a run-in tubular, a first tubular, a second perforated tubular, o-ring seals, and a bridge plug;

Figure 4b is a section view of the arrangement shown in Figure 4a, in which the second tubular has been partially expanded;

Figure 4c is a section view of the arrangement shown in Figures 4a-b, following expansion of the second tubular and removal of the expansion tool removed;

118 are formed as integral end members of radially slidable pistons 120, one piston 120 being slidably sealed within each radially extended recess 114. The inner end of each piston 120 (Figure 1) is exposed to the pressure of fluid within the hollow core of the tool 100 by way of the radial perforations in the tubular core 115. In this manner, pressurized fluid provided from the surface of the well, via a tubular, can actuate the pistons 120 and cause them to extend outward and to contact the inner wall of a tubular to be expanded.

Figure 4a is a section view of a sealing apparatus including an expansion tool 100 disposed on an end of a run-in tubular 410, a perforated or slotted tubular 420a, o-ring seals 470, 475, and a bridge plug 450. The perforated section of tubular replaces the need for a conventional production packer. The tubular 420a has a thickness that is commensurate with a desired load strength, but has slots or perforations 415 in the tubular 420a. The slots or perforations 415 reduce the tangential strength of the tubular 420a, so less work is required to expand the tubular 420a than would be required for a solid tubular.

Generally, the wellbore 400 has a first tubular, or casing, 460 having production perforations 480 disposed therein. A second tubular of smaller diameter, or production tubular 440 having a perforated, or slotted, section of tubular 420a, and a screen 430 disposed on the end thereof, are run into the casing 460. The perforated tubular 420a is connected to the production tubular 440 by any conventional means. Tubular 420a has perforations 415 which may be slots of oval shape, diamond shape, or any other geometry that reduces tensile hoop stresses, and a sleeve 425 concentrically covering substantially all of the perforations 415. The sleeve 425 is made of a ductile material, such as copper, stainless steel, tempered chrome, or a thermoplastic, and has an elastomer outer coating, or skin 435. The sleeve may be shouldered into position or welded into position. A first sealing member 470, such as an o-ring, concentrically covers a top portion of the outer diameter of the sleeve 425, and a second sealing member 475 concentrically covers a bottom portion of the outer diameter of the sleeve 425.

The expansion tool 100 is run into the tubular 440, 420a by a run-in tubular 410, or coil

6 is a plurality of non-compliant rollers 103 constructed and arranged to initially contact and expand a tubular prior to contact between the tubular and fluid actuated rollers 116. Unlike the compliant, fluid actuated rollers 116, the non-compliant rollers 103 are supported only with bearings and they do not change their radial position with respect to the body portion of the tool 100.

Figure 4b is a section view of the embodiment shown in Figure 4a, wherein the tubular 420b has been partially expanded by the expansion tool 100 into an inner diameter of the casing 460.

Figure 4c is a section view of the embodiment shown in Figures 4a-b, wherein the tubular 420c has been expanded into the casing 460 and the extension tool 100 removed. The junction between the tubular 420c and the inner diameter of the casing 460 has been substantially sealed and is structurally supported in this manner. Sealing members 470, and 475 further reinforce the seal at the top and bottom portions of the outer diameter of the sleeve 425 creating a "zero interference fit" between the tubular 420c and the casing 460. The sleeve 425 is essentially sandwiched between the inner diameter of the casing 460 and the outer diameter of the perforated tubular 420c. Preferably, no gap exists between the sleeve 425 and the casing 460. With the casing 460 now supporting the sleeve 425, the collapse strength of the sleeve 425 and tubular 420a is enhanced because the material must shear to fail rather than buckle. The constrained tubular 420c has a collapse strength of about two and a half times of the unexpanded tubular 420a. Additionally, the constrained tubular 420c and sealing members 470, and 475 can withstand pressure exerted in the annulus 490 above and below the junction, as well as the constrained tubular 420c, or combinations thereof, of up to about 10,000 psi (69 MPa). It is also contemplated that this aspect of the invention would have valuable application at higher pressures of up to about 15,000 psi (103 MPa), such as in deep water operations.

Figure 5a is a section view of a sealing apparatus, including an expansion tool 100 disposed on an end of coil tubing 510, or a run-in tubular, a junction 530 between a first tubular 560, such as a casing or a liner, and a second tubular 540 having a perforated or slotted tubular section 520a. In this aspect, the perforated section of tubular will replace

tubular 560 and the expansion tool 100 removed. Thereby sealing the junction 530 between the first and second tubulars 560, 540. Preferably, there is no gap between the sleeve 525 and the first tubular 560.

Figure 6 is a section view of a sealing apparatus, wherein the expansion tool 100 and a second tubular 540 having a section of perforated tubular 520a are placed into a wellbore as an assembly to create a seal between a junction 530 of two tubulars. The expansion tool 100 is disposed within the second tubular and held therein with a temporary, shearable connection 610. In one embodiment, the tool 100 and the tubular 540 are run into the wellbore 500 on a run-in tubular 620 which provides hydraulic fluid to the tool. The tubular 540 is then set by any conventional means or as described below with reference to Figure 7. The connection 610 is sheared by an upward force on the run-in tubular, the tool energized, and the perforated tubular 520a expanded.

Figure 7 is a top section view of an embodiment of the invention, wherein a second, smaller tubular 540, or liner, is partially expanded into a first tubular 560 to temporarily hang the second tubular. This embodiment is especially useful to set a liner in a wellbore without the use of a conventional liner hanger. To set the liner 540, the expansion tool 100 is energized and radially expands one or more sections 710 of the second tubular 540, disposed below the perforated section of tubular 520a, into the first tubular 560, thereby fixing the liner 540 in the wellbore. The unexpanded sections 720 of tubular 540 allow for the passage of fluid, such as cement. Depending upon the requirements of the operator, a fluid path may be left between the expanded tubular and the wellbore in order to provide a flow path for fluids, including cement. For example, the tubular may be expanded in a spiral fashion leaving flute-shaped spaces for the passage of cement or other fluids. The perforated section of tubular 520a is then expanded to create a seal between the two tubulars. Optionally, the second tubular 540 may be expanded to smooth out the one or more sections 710 after cementing and the tubulars 540 and 520a may then be expanded in a "bottom-up" fashion. It should be understood that the method described herein is especially useful in the embodiments of Figures 5a-c and 6.

While the foregoing is directed to the preferred embodiment of the present invention,

CLAIMS:

1. An apparatus for sealing an annular area in a wellbore, comprising:

a tubular having perforations at predetermined locations in a wall thereof;

a sleeve concentrically covering substantially all of the perforations;

a first sealing member concentrically covering a top portion of an outer diameter of the sleeve; and

a second sealing member concentrically covering a bottom portion of the outer diameter of the sleeve.

2. An apparatus as claimed in claim 1, wherein the first and second sealing members are o-rings.

3. An apparatus as claimed in claim 1 or 2, wherein the perforations are diamond slots or oval slots.

4. An apparatus as claimed in claim 1, 2 or 3, wherein the sleeve comprises:

a ductile material; and

an elastomer outer coating.

5. An apparatus as claimed in claim 4, wherein the ductile material is copper, stainless steel, tempered chrome, or a thermoplastic.

6. An apparatus for sealing an annular area in a wellbore, comprising:

a tubular having perforations at predetermined locations in a wall thereof;

a means for covering substantially all of the perforations; and

a first and a second means for sealing a top portion and a bottom portion between an outer diameter of the tubular and an inner diameter of the wellbore.

7. An apparatus as claimed in claim 6, wherein the means for covering is a sleeve concentrically covering substantially all of the perforations.

energizing the expansion tool and causing extendable members therein to extend radially to contact an inner wall of the second tubular; and

expanding the second tubular into substantial contact with an inner diameter of a junction between the first tubular and the second tubular.

15. A method as claimed in claim 14, further comprising:

hanging the second tubular by radially expanding one or more non-perforated sections of the second tubular into contact with a wall of the first tubular.

16. A method as claimed in claim 14 or 15, wherein the second tubular and the expansion tool are placed in the wellbore as an assembly.

17. A method as claimed in claim 14, 15 or 16, wherein the first tubular is a casing.

18. A method as claimed in claim 14, 15 or 16, wherein the first tubular is a liner.

19. A method as claimed in any of claims 14 to 18, further including circulating cement between the tubulars.

20. An apparatus for sealing an annulus area formed between the apparatus and a wellbore therearound, the apparatus comprising:

a slotted tubular having means for connection to another tubular at a first end; and

a sleeve member disposed around, attached to the slotted tubular, and covering substantially all of the slots, whereby the apparatus is expandable by a radial outward force applied to an inner wall of the slotted tubular.

21. A method of sealing an annular area in a wellbore, comprising:

placing a tubular in the wellbore; the tubular having perforations at a predetermined location and a sleeve concentrically covering substantially all of the perforations;

placing a means for expanding the tubular within the wellbore; and

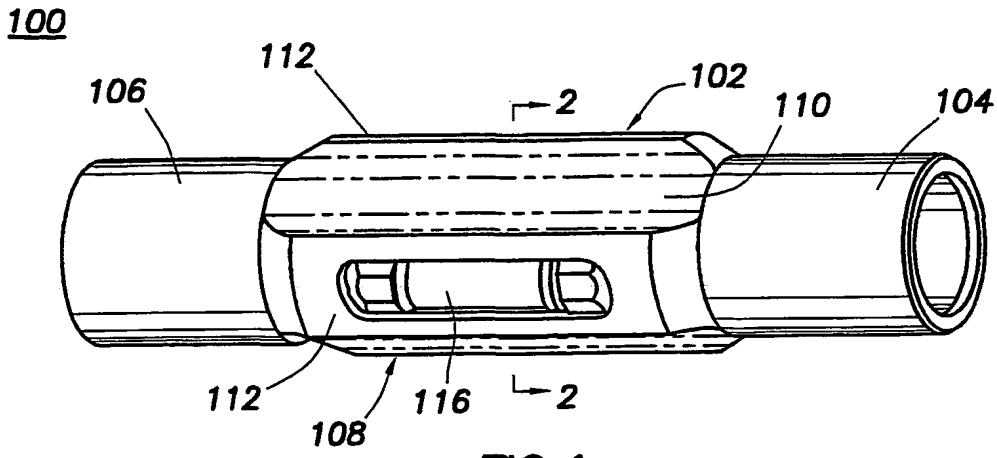


FIG. 1

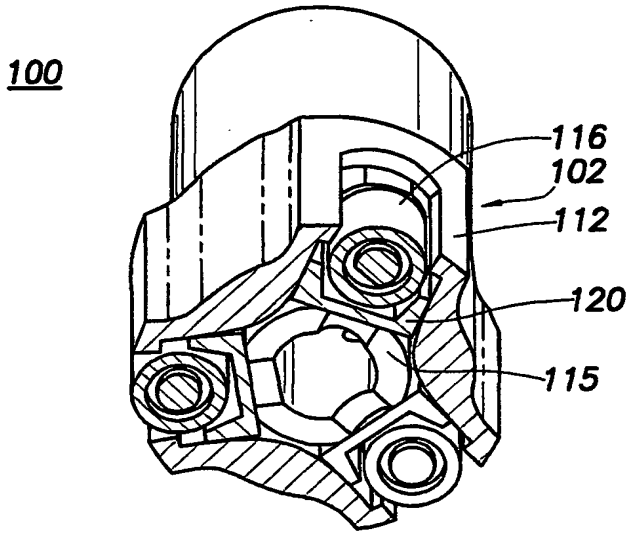
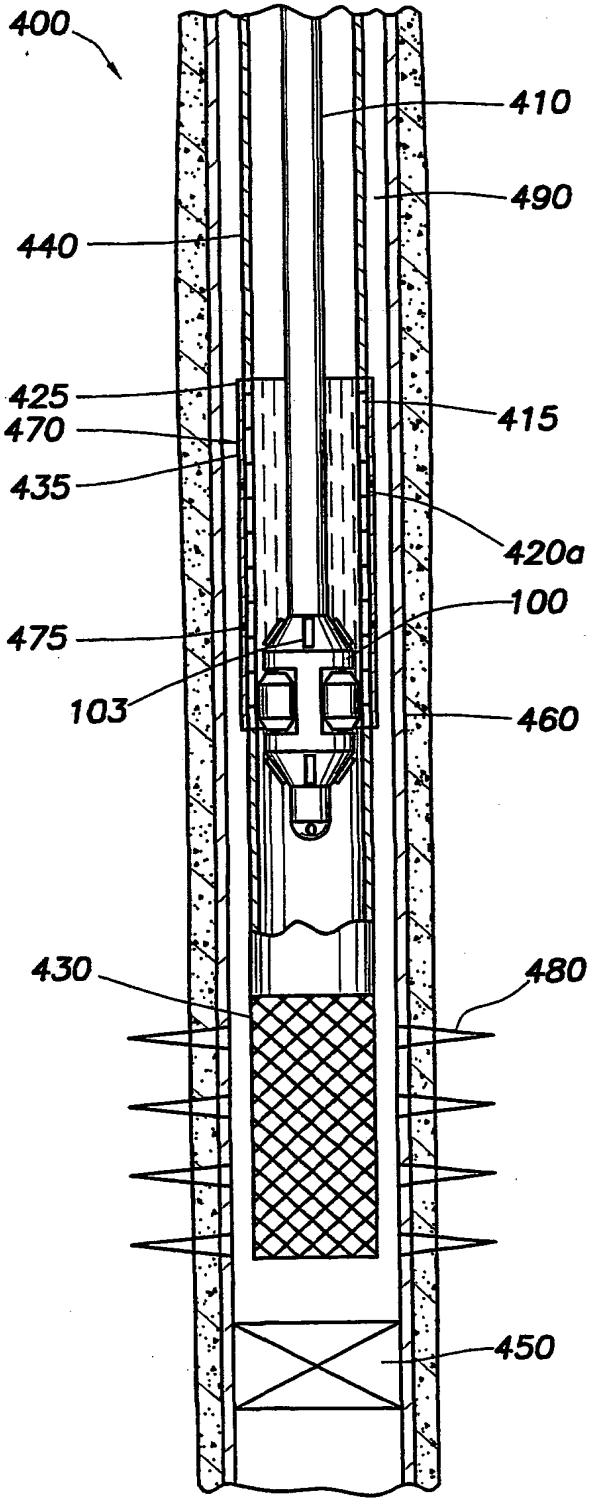


FIG. 2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410
490
440
425
470
435
415
420a
100
475
103
460
430
480
450

FIG.4a

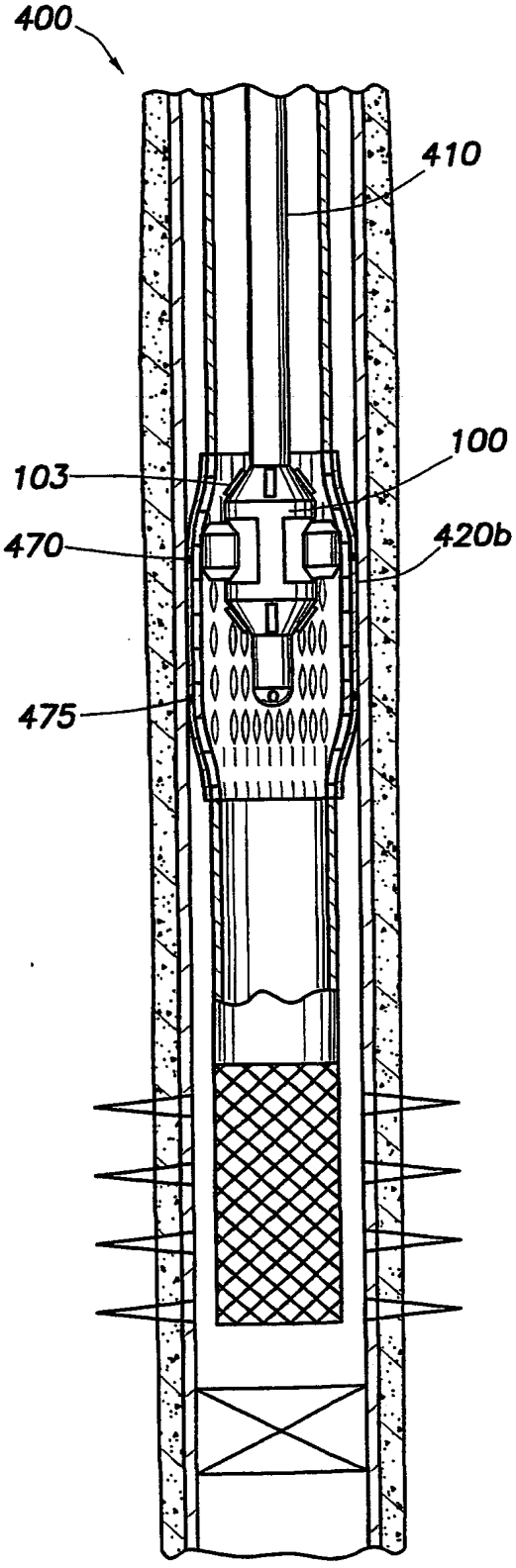
400
410
100
103
470
420b
475

FIG.4b

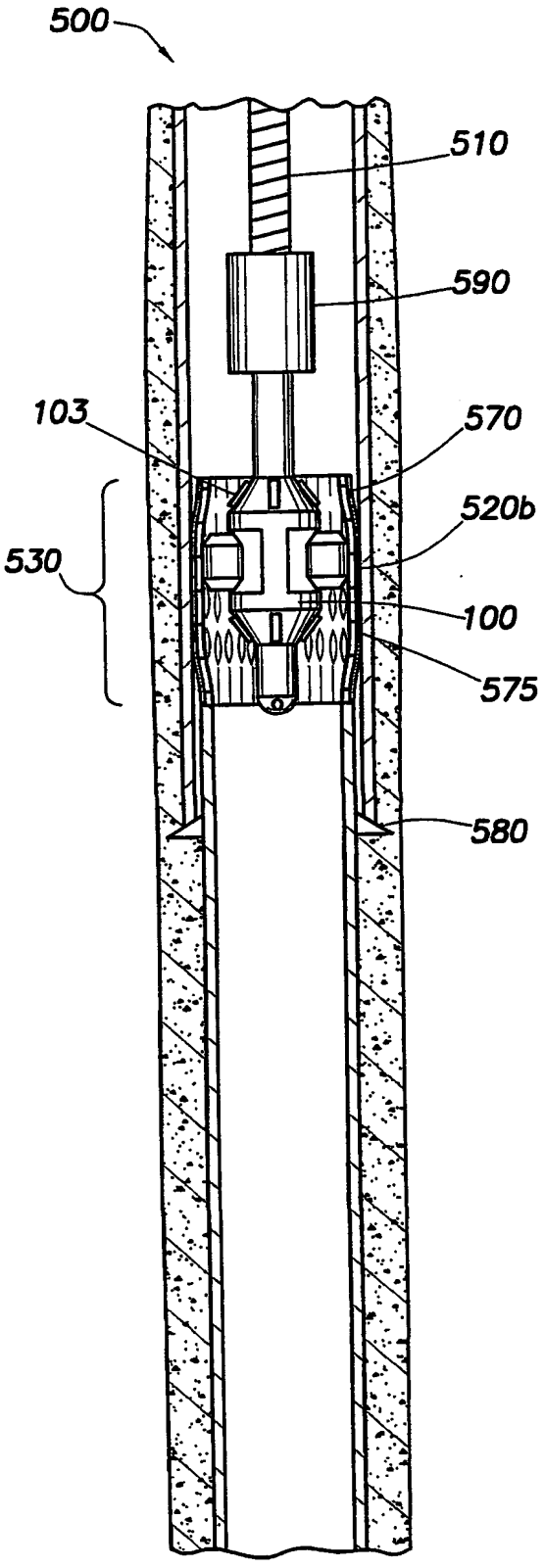

FIG.5b

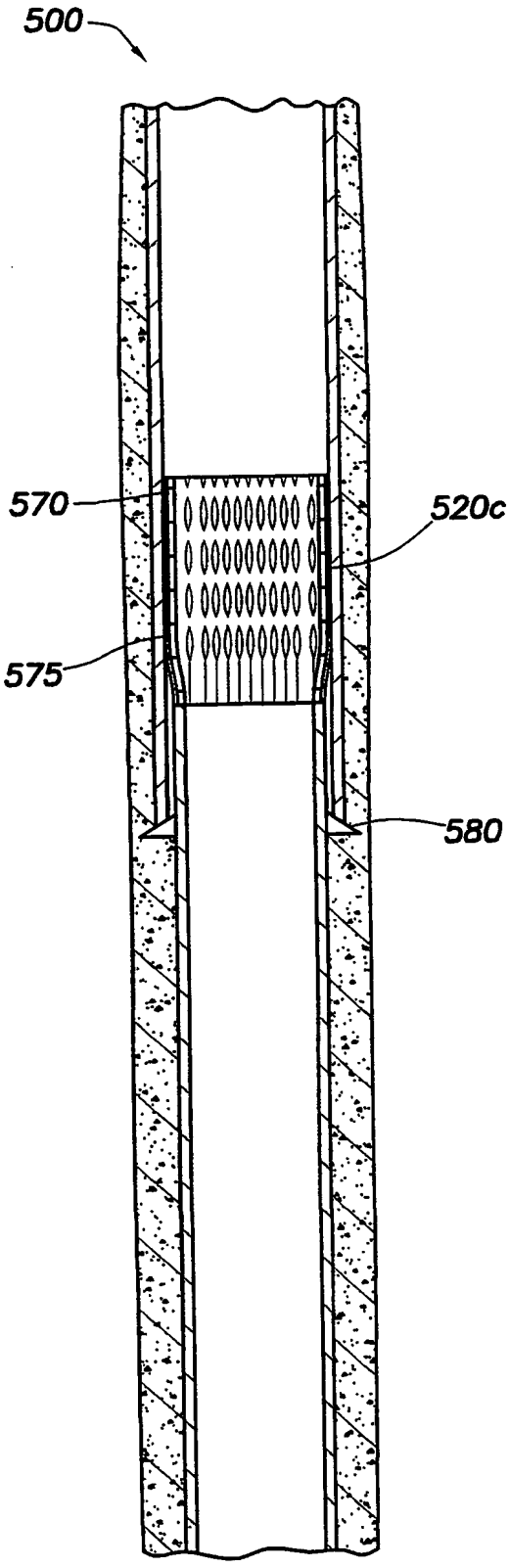

FIG.5c

INTERNATIONAL SEARCH REPORT

PCT/GB 02/01395

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B43/10 E21B33/134

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 00 50732 A (SHELL OIL CO) 31 August 2000 (2000-08-31) abstract; figures	1
A	GB 2 336 383 A (BAKER HUGHES INC) 20 October 1999 (1999-10-20) abstract; figures	1
A	US 6 189 616 B1 (GANO JOHN C ET AL) 20 February 2001 (2001-02-20) figures 8-10	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 September 2002	17/09/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Weiand, T

Form PCT/ISA/210 (second sheet) (July 1992)

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